A robust 3-D printed titanium-diamond hybrid fluorescence sensing platform

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Diamond is an important system for emerging quantum sensing technologies with a range of applications spanning biology, condensed matter, industrial and geophysics exploration. Optical temperature sensing with diamond has been well documented[1], however applying this technology to industries that require robust sensor properties at high temperature has been challenging. Here we showcase the properties of titanium with fluorescent diamond incorporated and report the first hybrid titanium:diamond (TiD) fluorescence sensing platform with the goal of using this technology for future temperature sensing applications.

1. Introduction

Three-dimensional (3D) printing is a rapidly evolving technology in the fields of medicine[2,3], defense and manufacturing. Technologies involving selective laser melting (SLM) direct energy deposition (DED) are heavily used in additive manufacturing due to their rapid and cost effective operation. Applying this layer-by-layer approach used in 3D printing results in highly accurate features for products in manufacturing. Titanium is one material that has been widely used within the mining industry due to its robust strength, and temperature and oxidation resistance. In this work we combine the well-known properties of titanium with diamond containing the Nitrogen-Vacancy (NV) colour center via the 3D printing process.

2. Results

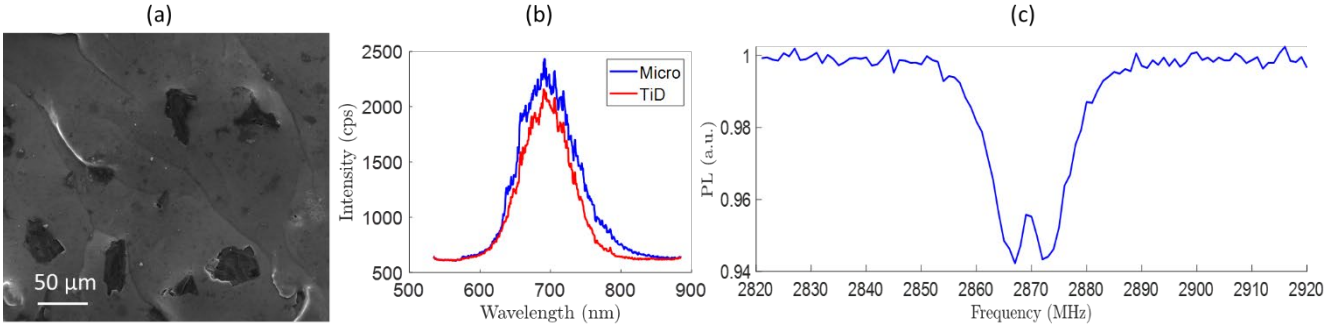

Figure 1: a) An SEM image of micro diamond particles surrounded in a titanium matrix. b) Fluorescence spectra of the micro diamond before (blue) and after (red) the 3D printing process. c) An optically detected magnetic resonance spectrum from NV centres in the hybrid TiD platform.

The TiD composite material was made by combining ~50 µm diameter microdiamonds with titanium powder, which was then co-deposited via laser metal deposition. An SEM of one of the resulting test plates is shown in Fig. 1a where the diamond particles appear as dark polygons embedded in the titanium matrix. We also observe the fluorescence properties of the diamond which are shown to be preserved during the write process (Fig. 1b) and a typical ODMR (Fig. 1c) spectrum as a result of NV fluorescence.

3. References

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